

September 28, 2017

F O R S C H U N G S P R A X I S
for
N.N.
Student ID XXXXXXXX, Degree XX-XX**Comparing Multi-Step Predictions for Gaussian Processes**Problem description:

Data-driven approaches from machine learning provide powerful tools to identify dynamical systems with limited prior knowledge of the model structure. Gaussian Processes (GPs) have been successfully employed to such identification task due to their Bayesian non-parametric nature [2]. However, due to their probabilistic nature, multi-step ahead predictions, required for many controllers, is difficult. Since for uncertain inputs, the predictive next step distribution of a Gaussian process is not tractable (even for Gaussian distributed inputs) it must be approximated. Various methods, e.g. moment matching [1], numerical quadrature [3] or Monte Carlo methods have been proposed. Therefore, the goal of this research internship is to implement these approaches in Matlab to be benchmarked against each in terms of precision and execution time. Special focus is also put on the analysis of error bounds of the approximation with the long-term goal to use it for convergence analysis.

Work schedule:

- **Week 1-2:** Literature research on existing methods
- **Week 3-7:** Implementation and developing a benchmark setting
- **Week 8-9:** Analysis of results and reporting

Literatur

- [1] Marc Peter Deisenroth. *Efficient reinforcement learning using Gaussian processes*, volume 9. KIT Scientific Publishing, 2010.
- [2] Carl Edward Rasmussen and Christopher KI Williams. *Gaussian Processes for Machine Learning*. MIT Press, Cambridge, MA, USA, January 2006.
- [3] Julia Vinogradska, Bastian Bischoff, Duy Nguyen-Tuong, Henner Schmidt, Anne Romer, and Jan Peters. Stability of controllers for Gaussian process forward models. In *International Conference on Machine Learning (ICML)*, number 48, pages 545–554, NY, USA, 2016. JMLR.

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Start: xx.xx.xxxx
Delivery: xx.xx.xxxx

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